Journal of Public Economics 125 (2015) 128–142

Contents lists available at ScienceDirect

Journal of Public Economics

journal homepage: www.elsevier.com/locate/jpube

Long-term care insurance, informal care, and medical expenditures ☆

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ARTICLE INFO

Article history:
Received 31 August 2012
Received in revised form 12 October 2014
Accepted 3 December 2014
Available online 11 December 2014

Keywords:
Long-term care
Home care
Institutional care
Informal care
Medical expenditures

ABSTRACT

This paper provides empirical evidence on the short-run impact of government subsidies of long-term care. We apply a regression discontinuity design using administrative data from South Korea to estimate the first-year impact of subsidies for formal home and institutional care on informal care use and medical expenditures. These subsidies lead to increases in formal long-term care utilization, even when accounting for crowd out of private spending. Our main finding is that the benefits of subsidized home and facility care are heterogeneous across physical function level, and therefore that setting policy accordingly has the potential to dramatically reduce medical expenses. We also find that formal long-term care is a substitute for informal care at the intensive margin, but do not find such evidence at the extensive margin. The results suggest that publicly financed home care may have limited impact among the more able, but that it may be both more cost-effective and beneficial than institutional care for the least able.

1. Introduction

As both developed and developing countries face rapidly aging populations, policies affecting long-term care—services targeting health or personal needs for people with chronic illness or disability—become increasingly important. For example, the share of those age 65 and over in the United States is expected to increase from 13.0% in 2010 to 20.2% in 2050. For Korea, the corresponding shares are 16.5% and 38.2%. Moreover, the shares of those age 80 and over, for whom the need for long-term care is highest, are expected to double from 3.7% to 7.4% in the United States and increase severalfold from 1.9% to 14.5% in Korea.[1] At the same time, societal changes such as declining family size and rising female labor force participation are likely to reduce the availability of family caregivers. Long-term care is also costly, with public and private spending in the U.S. totaling $183 billion in 2003, or 1.6% of GDP (GAO, (2005)). Moreover, a third of Medicaid spending in 2006 went towards long-term care (CBO, (2007)).

Much of long-term care is provided informally. As needs expand and costs rise, understanding the role of informal care in meeting this escalating demand becomes increasingly important. This paper aims to shed light on an important aspect—the substitutability of formal for informal care. For example, if formal long-term care services directly substitute for—rather than supplement—informal care, the cost of provision will rise without necessarily increasing the total care received by disabled persons. This could have welfare consequences for the caregivers in terms of their participation in the labor force as well as on intergenerational household bargaining. Thus, understanding the welfare impacts will require understanding under what situations and through which services formal care substitutes for informal care. Additionally, as governments develop and refine long-term care policies, implications for economic efficiency will be substantial. Informed policies will need to assess the costs and benefits of subsidizing various types of care—in particular, home versus facility—measured both by direct costs of subsidization as well as potential costs or savings from other medical expenses.

In this paper, we study subsidies for formal home and facility care and their corresponding first-year impact on informal caregiving and medical expenditures in Korea. This study has a number of advantages that allow us to address this topic and improve upon the existing literature. First, we account for endogeneity in the choice of long-term care by using plausibly exogenous variation induced by a regression discontinuity design. Specifically, long-term care benefits in Korea are assigned based on an assessment score that is very difficult to precisely control. Second, these benefits vary at multiple cutoffs which allow us to separate the impact of home and institutional care benefits. Specifically, the first threshold set isolates the impact of just home care benefits for

☆ We would like to thank Douglas Almond, Bentley MacLeod, and Cristian Pop-Eleches for their invaluable guidance and support. We are also grateful to the editor, Joseph Doyle, and two anonymous reviewers for insightful comments that significantly improved the paper. We also thank Janet Currie, Olle Folke, Wojciech Kopczuk, Soonman Kwon, Benjamin Marx, Christine Pal, Miguel Urquiola, Till von Wachter, and seminar participants at Columbia University, Mathematica Policy Research, Seoul National University, and Yonsei University for useful comments. We thank Taewha Lee of Yonsei University for the opportunity to participate in the project "Impact Analysis of Long-Term Care Insurance," initiated and funded by the Ministry of Health and Welfare, Korea, of which this research is a part. Wilfredo Lim gratefully acknowledges support from the Sasakawa Young Leaders Fellowship Fund during the initial stages of this research. All errors are our own.

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[1] Data are from Colombo et al. (2011).

http://dx.doi.org/10.1016/j.jpubeco.2014.12.004
0047-2727/

individuals who are partially dependent for some activities of daily living (ADLs) (hereafter, "more able")—for example, those who require a walking aid to move around; the second threshold allows us to measure the impact of an increase in facility care and decrease in home care among people who are partially dependent for several ADLs (hereafter, "less able")—for example, those who spend most of their daily life in a wheel chair; and the third threshold isolates the impact of an increase in home care and decrease in facility care among people who are completely dependent for several ADLs (hereafter, "least able")—for example, those who are bedridden.[2] Third, our analysis benefits from unique administrative data on formal home and institutional care, informal care, and medical expenditures.

Our main finding is that the benefits of home and facility care are heterogeneous across physical function level and therefore that setting policy appropriately has the potential to dramatically reduce medical expenses. Specifically, substantial reductions in medical expenses arise from incentivizing transitions from facility to home care for the least able. This finding is not likely culturally or context specific and is consistent with programs in the U.S. such as Money Follows the Person that seeks to transition people with Medicaid from institutions to the community. We also do not find evidence that formal long-term care is a substitute for informal long-term care at the extensive margin, but do find evidence that it does so at the intensive margin. Indeed, given that family ties tend to be relatively stronger in Korea, we argue that our results constitute a lower bound for similar effects in the U.S., and may be directly indicative of countries with relatively stronger family ties, such as many developing countries.

Specifically, we find that among more able individuals, government subsidies for formal home care lead to an increase in its utilization, with no statistically significant impact on informal caregiving at the extensive margin, as measured by child caregiving and independent living. We do find evidence for a reduction at the intensive margin, measured by the use of short-term respite care, which provides temporary relief for the recipient's caregiver. We also do not estimate a statistically significant impact on medical expenses. Among less able individuals, increased use of facility care and decreased use of home care due to the subsidization of institutional care lead to statistically significant reductions in informal caregiving but not medical expenses. Among the least able individuals, increased home care and decreased facility care utilization lead to substantial decreases in medical spending, largely accounted for by a reduction in hospital expenses. From a policy perspective, these findings suggest that among more able individuals, home care may be reduced with minimal detriment to their health; and that among the least able, incentives to transition from facility to home care may improve quality of life and reduce program costs overall.

We explore alternative mechanisms for explaining our findings. First, we determine whether crowd out explains our lack of findings on informal care. While we find that subsidies for long-term care lead to partial crowd out of private spending on long-term care, long-term care utilization still increases overall. Thus, crowd out is not likely the sole reason for our limited findings on informal care. We also assess the impact of subsidies for long-term care on short-run mortality, as this measure is important in and of itself and in order to rule out differential mortality in affecting our estimates. We find no statistically significant differences in mortality across all thresholds. Lastly, we show that our results are robust to various checks and specifications of our estimation strategy.

The remainder of this paper is structured as follows. Section 2 provides a brief discussion of the literature and our contribution. Section 3 explains Korea's Long-Term Care Insurance program and motivates our empirical strategy. Section 4 describes the data. Sections 5 and 6 present the empirical framework and results, respectively, followed by additional robustness checks in Section 7. Section 8 provides a brief discussion and Section 9 concludes.

[2] See Table 1 for additional details on the characteristics of individuals in each grade level.

2. Literature review

This paper studies the impact of subsidies for formal home and facility long-term care on informal caregiving and medical expenditures. In doing so, it contributes to the literature on the substitutability of formal for informal care and, more generally, the cost-effectiveness of public financing of long-term care.

One issue in the related literature is that of endogeneity, such as confounding unobserved characteristics that may lead to misleading findings. For example, to the extent that formal and informal care are positively correlated with unobserved negative health shocks, a naive analysis would find them to be complements even if they were substitutes. One way to address endogeneity is through the use of instrumental variables. Using the number of adult children and presence of a daughter who has no child at home as instruments, Lo Sasso and Johnson (2002) find that frequent help from children for basic personal care reduces the likelihood of future nursing home use. Using the number of children and whether the eldest child is a daughter as instruments, Van Houtven and Norton (2004) find that informal care reduces home health care and nursing home use. Using children's gender, marital status, and distance as instruments, Charles and Sevak (2005) find that receipt of informal home care reduces the probability of future nursing home use. However, it is unclear whether the necessary exclusion restrictions would be satisfied, given the complexity of fertility decisions and bargaining over intergenerational transfers. Thus, it is useful to assess the robustness of these results through studies based on more plausibly exogenous sources of variation.

The Balanced Budget Act of 1997 induced such a source of variation. This act led to regional variation in overall decreases in Medicare reimbursement for home care services. Using this source of variation, McKnight (2006) finds resulting reductions in home care utilization that were not offset by increases in institutional care or other medical care. Using the same source of variation, Orsini (2010) and Engelhardt and Greenhalgh-Stanley (2010) find reductions in independent living, and Golberstein et al. (2009) find increases in the probability of the use of informal caregiving.

The Channeling demonstration in the U.S. provides another opportunity to assess the relationship between informal and formal home care, through randomized evaluation. This experiment sought to substitute a system of home and community care for institutional care. Christianson (1988) and Pezzin et al. (1996) assess the impact of public home care provision and find limited reductions in the care provided by informal caregivers. However, the latter paper does find a significant increase in the probability that unmarried persons live independently. This highlights the importance of considering both informal caregiving directly and independent living.

Regarding impacts on other medical expenditures, McKnight (2006) finds suggestive evidence that reductions in home health care reimbursement and utilization did not lead to increases in other medical care and were not associated with adverse health consequences; however the estimates were not precise enough to rule out a sizable impact. Evaluating the impact of Channeling on other medical expenses, Wooldridge and Schore (1988) find large reductions in nursing home use among those who were already in a nursing home at baseline but no statistically significant change on the use of hospital, physician, and non-physician medical services.

Another limitation of the existing literature is the lack of evidence on institutional care. Moreover, even though understanding the impact of institutional care on health and other medical expenses is necessary for cost–benefit analyses, very little is known at this point.[3] In addition, existing evidence on home care is limited in accounting for institutional care and in being generalizable to a broader population of the elderly.

[3] In a review paper, Ward et al. (2008) conclude "there is insufficient evidence to compare the effects of care home environments versus hospital environments or own home environments on older persons rehabilitation outcomes."

This study attempts to fill these gaps directly. By using longitudinal administrative data with measures of home care, institutional care, informal care, and medical expenditures, and a unique policy affecting the broad population of the elderly, we are able to account for the complex interrelationship among the various types of care as well as evaluate the corresponding impacts on health and medical expenses.

Lastly, the literature above is based on findings in the United States and other Western countries. This paper adds to the literature by providing evidence from an Asian country, which is important given that population aging is a worldwide phenomenon.

3. Background and identification

Korea implemented universal health coverage in 1989. Individuals are covered either by National Health Insurance (NHI) or Medical Care Assistance (MCA), programs that are overseen by the National Health Insurance Corporation (NHIC). The primary distinction between NHI and MCA is that the latter serves poor individuals. While health insurance coverage includes outpatient care, inpatient care, and prescription pharmaceuticals, no coverage for long-term care was included prior to 2008. In response to this, and due to the demographic and cultural changes affecting the need and provision of long-term care, National Long-Term Care Insurance was implemented in July 2008. This program provides coverage for individuals age 65 and over and those with age-related needs such as dementia and Parkinson's disease.[4] The copayment for home care services is 15% while that of institutional care is 20%, but the poor (MCA individuals) are exempt from copayments, and individuals with certain conditions face reduced copayments.[5]

Long-term care insurance covers two categories of service benefits: home care and institutional care.[6] Home care includes services provided at the beneficiary's residence. This includes home help where a caregiver provides support for physical activities or housework, home bathing where a caregiver assists the beneficiary in bathing, and home nursing where a nurse provides assistance with such things as medication and dental hygiene. Also included within home care benefits is short-term respite care which covers a short-term stay in a facility to allow the caregiver relief from caregiving activities. Institutional care benefits cover long-term residence in a facility where meals, care, and other necessities required for daily function are provided. See Appendix Table B.1 for more details. The delivery of long-term care is primarily administered through private providers, similar to general health care.

To receive long-term care benefits, individuals must apply, submit a doctor's referral, and be evaluated by an assessment team from the NHIC. Benefits are determined based on an adjusted score, which is the sum of two components, a preliminary score and committee points. That is,

$$\text{adjusted score} = \text{preliminary score} + \text{committee points}.$$

The preliminary score is a complex, highly nonlinear function of the responses to 52 evaluation questions, encompassing physical and cognitive function, behavior, nursing assistance, and rehabilitation.[7] Then a local assessment committee, following guidelines determined at the national level, is able to add or subtract up to five "committee points" to this score, based on the assessment questions and the doctor's referral.[8]

The adjusted score is used to determine benefits, as depicted in Table 1. Individuals whose adjusted score is below 55 are not eligible for long-term care benefits. Individuals whose adjusted score is 55 or above (Grade 3) are eligible for reimbursement of formal home care services up to 750 USD per month, which corresponds to approximately 2 h of home help care per day.[9] Individuals who score 75 or above (Grade 2) become eligible for reimbursement of institutional care, or a home care benefit maximum of 900 USD per month.[10] Individuals who score 95 or above (Grade 1) continue to be eligible for reimbursement of institutional care, or a home care benefit maximum of 1100 USD per month. The price of institutional care is 40 USD per day and 45 USD per day for individuals in Grades 2 and 1, respectively. To the extent that there is a copayment, this implies that the cost of institutional care for an individual scoring 95 is discretely higher than the cost for an individual scoring 94.9.[11] As a result, the increased cost of facility care along with the more generous home care benefit incentivizes individuals to transition from institutional to home care, at the margin.

Applicants are notified of their classification, not their score. They are reevaluated when major changes to their physical or mental status occur, for the renewal of benefits, or if they appeal for a reevaluation.[12] Benefits must be renewed every twelve months, with the exception of those with significantly high scores (>100) who may have up to eighteen months.

Fig. 2a illustrates the source of identification in our research design, which is driven by the fact that there is a maximum—of five—to the number of committee points that can be added. The probability that the adjusted score exceeds the 55 point threshold is plotted against the preliminary score (recall that adjusted score = preliminary score + committee points).[13] When the preliminary score is below 50, the probability that the adjusted score exceeds the 55 point threshold is effectively zero, consistent with the guideline that the maximum number of committee points that can be added is five. When the preliminary score is above 55, the probability that the adjusted score exceeds the 55 point threshold is effectively one, reflecting the rarity with which the committees subtract points around this threshold. Between 50 and 55, enough points are added to the preliminary scores of a fraction of individuals so that their adjusted scores exceed 55. Note that this illustration suggests not only an explicit threshold at 55 (and similarly at 75 and 95), but also an implicit threshold at 50 (and similarly at 70 and 90). That is, scores above the explicit threshold of 55 virtually guarantee eligibility; scores below the implicit threshold of 50 virtually exclude the possibility of eligibility.

Correspondingly, this figure highlights the source of identification for our analysis: comparing similar individuals who have different probabilities of treatment.[14] For instance, those with preliminary scores just below 50 have a probability of eligibility for home care benefits of zero. Those with preliminary scores just above 50 have a probability of about 8%. This allows us to use variation in the probability of eligibility in order to look at the impact of eligibility on formal long-term care utilization

[4] See Seok (2010) for further details on LTC insurance in Korea.

[5] Individuals who face reduced copayments include the disabled, people with rare and incurable diseases, and the marginally poor.

[6] In exceptional cases (e.g. for individuals who live in remote regions with no access to long-term care services), cash benefits are provided. However, this represents less than 0.2% of cases.

[7] An example of a physical function question is whether the individual is fully independent, partially dependent, or fully dependent for bathing. For more details, including a description of the calculation of the preliminary score, see 10.

[8] Committee members are trained annually and when the guidelines are changed.

[9] See Table 1 for general descriptions of individuals falling into each category. All amounts in this paper are converted to USD at the rate of 1100 KRW: 1 USD.

[10] If one were to use both types of care in the same month, the home care benefit would be prorated based on the number of facility days used. However, home and facility care are inherently incompatible with each other (in our data, only 3% of individuals utilize both types of benefits in the same year). Thus, the use of both types of services in the same month is more likely due to changes in health status than simultaneous use.

[11] The price of institutional care for those in Grade 1 is higher than for those in Grade 2 because more intensive care is necessary for those in Grade 1. Since the copayment rate is 20%, individuals in Grades 2 and 1 pay $8 and $9 per day, respectively.

[12] They are able to appeal indefinitely, though this process typically takes longer than one month.

[13] See Section 5 for a discussion of the specification used to generate the figures.

[14] We discuss our empirical strategy more formally in Section 5.

Table 1
Overview of grades of benefits.

Classification	Criteria	Description	Home care max benefit (USD)	Institutional care daily benefit (USD)
No benefits	Score < 55		None	None
Grade 3	55 ≤ score < 75	Partially dependent for some ADLs (e.g. require walking aid) ("more able")	750/month	None
Grade 2	75 ≤ score < 95	Partially dependent for several ADLs (e.g. maintain daily life in wheelchair) ("less able")	900/month	40/day
Grade 1	95 ≤ score	Completely dependent for several ADLs (e.g. bedridden) ("least able")	1100/month	45/day

and relevant outcomes, including independent living, informal caregiving, and medical expenditures.

The different grades of benefits afford us the possibility of studying several aspects of long-term care utilization. Our main analysis focuses on the 50, 55, 70, and 95 cutoffs. We exclude the 75 threshold because of discontinuities in the density of the preliminary score and levels of baseline characteristics at that point. We also exclude the 90 threshold because there is no statistically significant change in eligibility at that point. Among the remaining thresholds, the 50 and 55 thresholds isolate the impact of home care benefits; the 70 threshold isolates the impact of home and institutional care benefits versus just home care benefits; and the 95 threshold allows us to look at the impact of an increase in the price of institutional care along with an increase in the maximum benefit for home care.

4. Data

This study uses a merged dataset combining NHIC administrative data for National Long-Term Care Insurance (NLTCI) and National Health Insurance (NHI). The sample consists of 171,373 individuals who were assessed in 2008 and 2009. The NLTCI data spans 2009 and the first half of 2010 and contains information on gender, age, living and caregiving arrangements, preliminary and adjusted scores from the first eligibility assessment, and long-term care utilization.[15] The NHI data spans 2008 and 2009 and contains annual total medical, hospital, outpatient, and pharmacy expenditures. Our main explanatory variable is the 2009 preliminary score. Our main measures of formal care are 2010 home care expenditures and number of institutional care days, as well as indicators of their use. We measure home care in expenditures as an aggregate measure to capture the variety of home care services that are used. Our main measures of informal care are 2010 indicators of whether a child is the primary caregiver and whether the individual lives independently (that is, alone or with a spouse in his or her own home—those living in facilities are inherently not living independently). This measure of independent living is consistent with the previous literature. Our main measures of (non-LTC) medical utilization are 2009 total medical and hospital-specific expenses.[16]

Columns (1) to (4) of Table 2 displays summary statistics for covariates and key outcomes, by grade. All measures are at baseline (2008 for NHI variables; 2009 for NLTCI variables), except for long-term care facility days and home care expenditures. ADL Index is a composite score based on activities of daily living questions from the assessment, with a higher number indicating less function. Individuals with higher scores are sicker as measured by the ADL Index, medical expenditures, and hospital days, and tend to have more resources as measured by insurance contribution and MCA percentage. Finally, sicker individuals are less likely to have a child caregiver and live independently.

As will be further discussed in Section 5, an important assumption for our identification strategy is that individuals on each side of each threshold are comparable. A test of this assumption is to check the balance of observable characteristics across the thresholds. Columns (5) to (8) of Table 2 contains estimates of the discontinuities around the thresholds for predetermined variables that are likely to be correlated with our dependent variables of interest. Most of the variables appear to be continuous around the thresholds (the empirical specifications, such as the choice of bandwidth, are discussed in Section 5). However, the baseline probability of living independently appears to vary at the 55 threshold by 7 percentage points, about 20% relative to the mean of 36 percentage points to the left of the threshold, and similar in magnitude to the first stage effect of the subsidies on the probability of formal home care utilization described in a later section. In addition, age and medical expenditures appear to vary at the 95 threshold. We address these findings next.

Because we are testing numerous variables and thresholds, some discontinuities will be statistically significant by random chance. As a result, we conduct two tests which account for this, with results presented in the last two sets of rows of Table 2. First, we look at a summary measure—the predicted medical expenditures from a regression of medical expenditures on the other predetermined variables. There appear to be no discontinuities in predicted medical expenditures at our preferred bandwidth. Second, we test whether the discontinuities are jointly significant by seemingly unrelated regression, as described in Lee and Lemieux (2010). Consistent with the first exercise, we find no thresholds for which the discontinuities are jointly significant at the preferred bandwidth. This leads us to believe that our results are not impacted by unobserved confounders at the 50, 55, 70, and 95 preliminary score thresholds.

Although the tests of joint significance described above suggest that crossing the thresholds provides plausibly exogenous variation in benefits, we controlled for the statistically significant baseline differences in covariates in our empirical approach. Specifically, we included variables for age, gender, insurance, region, health insurance contribution, and ADL index as controls in our regression estimation (see Section 5 for additional details). Moreover, for our measures of informal care and medical utilization (whether a child is the primary caregiver; whether the individual lives independently; medical expenses; hospital expenses), outcomes for which we saw some statistically significant baseline differences, we perform the regression analysis on the first difference of the outcome variables (the outcome variables minus their lagged [baseline] values) to subtract out these baseline differences around the thresholds.[17] Based on the tests of joint significance and our additional controlling for baseline differences, we believe that our results are not impacted by unobserved confounders. However, the

[15] Because we only observe NLTCI data for the first half of 2010, our sample is reduced by approximately half when looking at informal care outcomes. Analysis of predetermined variables shows that covariates are balanced in the reduced sample.

[16] These amounts are inherently exclusive of long-term care expenses. They are total expenditures throughout 2009. Since the average date for the preliminary score is mid-June 2009, for these measures we are assessing impacts over an average of six months.

[17] As described in Lee and Lemieux (2010), this approach yields the same treatment effect of interest as if the analysis were performed on the post-baseline values directly.

Table 2
Summary statistics and covariate balance.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Preliminary score				Covariate balance			
	[45,55)	[55,75)	[75,95)	95+	50	55	70	95
Age	77.24	77.92	79.08	77.98	−1.00*	0.18	0.05	−3.79**
	(8.32)	(8.86)	(8.73)	(9.68)	(0.42)	(0.34)	(0.32)	(0.50)
Female	0.77	0.73	0.74	0.73	−0.08**	0.00	−0.03*	−0.02
	(0.42)	(0.44)	(0.44)	(0.44)	(0.02)	(0.02)	(0.02)	(0.02)
Urban	0.72	0.76	0.79	0.77	0.00	−0.07	0.00	−0.02
	(0.45)	(0.43)	(0.41)	(0.42)	(0.02)	(0.02)	(0.01)	(0.02)
Insurance contribution	44.88	57.60	65.30	66.77	3.16	−1.17	−3.94	6.65+
	(69.28)	(74.66)	(75.54)	(79.57)	(3.50)	(3.21)	(2.77)	(3.91)
MCA	0.42	0.30	0.23	0.24	−0.03	−0.01	−0.02	−0.01
	(0.49)	(0.46)	(0.42)	(0.43)	(0.02)	(0.02)	(0.02)	(0.02)
ADL index	14.65	19.58	26.89	33.32	0.12	−0.12	0.34+	1.75**
	(1.08)	(3.07)	(3.64)	(3.01)	(0.18)	(0.14)	(0.18)	(0.29)
Medical expenditures	3486	3777	4748	6311	311	42	−28	801*
	(4825)	(5531)	(6846)	(8614)	(202)	(167)	(206)	(396)
Hospital days	18.63	24.86	42.52	64.87	2.52	0.27	1.62	5.64
	(58.67)	(70.81)	(93.28)	(118.01)	(2.00)	(1.53)	(2.44)	(5.16)
Child caregiver	0.27	0.30	0.23	0.19	−0.04	−0.03	0.00	−0.03
	(0.44)	(0.46)	(0.42)	(0.39)	(0.04)	(0.02)	(0.02)	(0.03)
Live independently	0.36	0.16	0.03	0.01	0.05	0.07**	−0.02	0.03
	(0.48)	(0.37)	(0.17)	(0.12)	(0.05)	(0.03)	(0.02)	(0.03)
LTC facility days	38.13	76.37	169.46	164.84				
	(93.48)	(144.06)	(167.91)	(168.95)				
Home care exp	4427	5308	3696	3820				
	(3073)	(3782)	(4315)	(4753)				
N	15,377	75,608	40,557	35,914				
Predicted medical expenditure					141	115	183	465+
					(127)	(95)	(130)	(274)
SUR p-value					0.49	0.19	0.34	0.23

Notes: The sample consists of individuals who were assessed for long-term care insurance in 2008 and 2009. All measures are at baseline, except for long-term care facility days and home care expenditures. See text for definitions of variables. Columns (1) to (4) present summary statistics by Grade. Columns (5) to (8) present estimates of the difference in levels of the covariates at the relevant threshold.

** $p < 0.01$.

* $p < 0.05$.

+ $p < 0.1$.

baseline differences nonetheless warrant caution in interpreting the results.

5. Empirical framework

We conduct a regression discontinuity analysis at the thresholds 50, 55, 70, and 95 of the preliminary score that exploit the discontinuous probabilities of eligibility resulting from the committee portion of the adjusted score. Specifically, the aim is to compare outcomes across individuals with similar characteristics but differing probabilities of eligibility for benefits.

The corresponding regression model we estimate is:

$$\text{outcome} = \beta \mathbf{1}\{S \geq \tau\} + f(S) + \gamma X + \varepsilon, \quad (1)$$

where S is the preliminary score, $f(S)$ is a function of the score, τ is the relevant cutoff, and X is a set of control variables—age, age squared, gender, insurance dummies, region type dummies, health insurance contribution (a proxy for income), and ADL index—which serve to improve the precision of the estimates.[18] The outcome variables include measures of formal LTC (home care expenditures; number of institutional care days), informal care (indicator of whether a child is the primary caregiver; indicator of whether the individual lives independently), and medical utilization (total medical expenses; hospital-specific expenses). Measures of formal care are included in the regression model in levels, and informal care and medical utilization are included as first differences in order to account for baseline differences in these variables.[19] In Section 7, we discuss the sensitivity of our results to this specification.

In implementing the regression discontinuity design, an important consideration is the modeling of $f(S)$. One approach is to model it parametrically through linear, quadratic, or higher order polynomials that are allowed to differ on each side of the cutoff. The other approach, which we follow here, is to estimate the discontinuity nonparametrically, which we implement by local linear regression with a rectangular kernel.[20] Our preferred estimates are based on a bandwidth of 2.5 points, in order to reduce bias by staying close to the cutoff while still maintaining enough precision. To assess the sensitivity of our results,

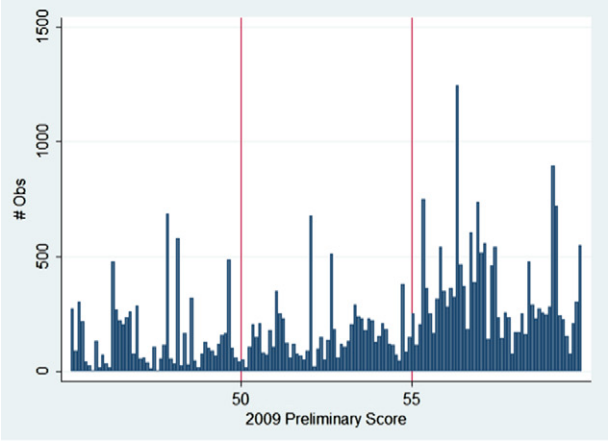
[18] We also estimated an alternative specification of the regression model where instead of including a quadratic in age, we included individual age indicators. The direction, size, and significance of the coefficients are similar, suggesting that the quadratic in age is sufficiently flexible for this analysis.

[19] Because our measures of informal care and medical utilization are included in the regression as first differences, the lagged value cannot be included as a control. While it is possible to include the lagged values of the other outcome variables as controls, we chose not to do so in order that the set of all controls would be consistent across models. Appendix Tables B.4 and B.5 provide our main results based on an alternative specification of Eq. (1), where the lagged values of other outcome variables are included as controls and age is specified as age dummies instead of a quadratic. For example, when the first difference of medical expenses is the dependent variable, the baseline value of medical expenses is not included as a control; but the baseline values of the other outcome variables (i.e. indicator of a child caregiver, indicator of living independently, and hospital expenses) are included as controls. We find that the results are qualitatively similar, though the results on medical expenses at the 95 threshold are only significant at the 10% level instead of the 5% level.

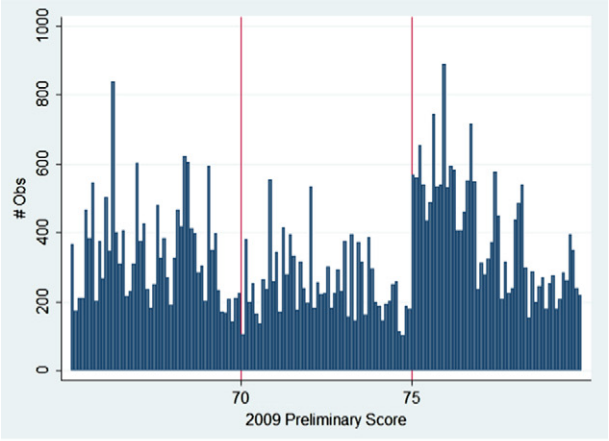
[20] As noted in Lee and Lemieux (2010), the choice of kernel typically has little impact and while a triangular kernel is boundary optimal, a more transparent way of putting more weight on observations close to the cutoff is to reestimate a rectangular kernel based model using a smaller bandwidth.

we also evaluate the robustness of our results to other bandwidths and higher order polynomials in Section 7.2.

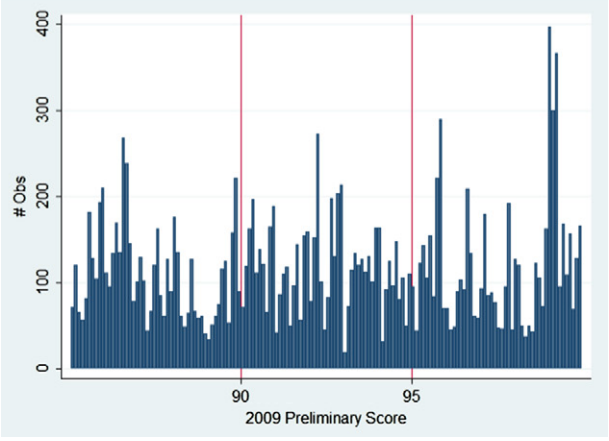
A critical assumption to our identification strategy is that individuals just below a threshold are indeed comparable to individuals just above a threshold. One potential threat to this assumption is whether individuals are able to precisely sort around the threshold (Lee, (2008)). If this assumption holds, then one implication is that the density of scores should be continuous around the threshold. Fig. 1 displays the density of scores, in 0.1-point bins, in our sample around each threshold. We see no indication that the density is discontinuous around the target thresholds. Appendix Fig. B.2a displays a smoother density of scores, in 1-point bins, which suggests a possible discontinuity in the density at 55. To address concerns of possible sorting through learning by doing, Appendix Fig. B.2b displays the density of scores for those who were assessed in April of 2008, the first opportunity for eligibility evaluations and two months before the actual launch of the program.[21] To the extent that the patterns in the 2009 density are due to sorting, we would not expect to see them in the April 2008 density, when individuals have no experience with how responses are mapped into scores. A comparison of Appendix Fig. B.2a and B.2b indicates that the distribution of scores around the thresholds is strikingly similar for both periods.



(a) Around Grade 3 Thresholds



(b) Around Grade 2 Thresholds



(c) Around Grade 1 Thresholds

Notes: 2009 preliminary score in 0.1 point bins.

Fig. 1. Histograms of scores.

Appendix Fig. B.2 illustrates the complexity of the score function and the amount of variation inherent in the score, providing evidence that manipulation of the score is difficult and not likely. We take the set of individuals who responded "fully independent" for changing position and changed their response to "needs partial support." We recalculate their score and then plot this against their original score. Highlighting how highly interactive the score function is, note how the change in the response may lead to a change in the score ranging from a few points to more than ten points. This example indicates three things. First, it is difficult to precisely control the score. Second, there is a large degree of randomness within a few points. Third, it is possible that a response that indicates a sicker individual may actually lead to a *reduction* in points. This results from the highly interactive nature of the way the score is calculated.[22]

To the extent that there is no sorting and that the observed distribution of scores is due to the score function, individuals on each side of the threshold may still be comparable. As discussed in Urquiola and Verhoogen (2009), stacking alone may not violate the regression discontinuity assumptions since violation arises from the interaction of the stacking and the endogenous sorting of individuals. Thus, the more fundamental question for our identification strategy is whether the distribution of predetermined characteristics is identical on each side of the threshold, for which we provided supportive evidence in Section 3.

6. Results

We begin with our main results on the impact of eligibility on utilization of formal long-term care, informal caregiving, and medical expenditures in Sections 6.1 to 6.3. Within each section, we address crowd out of private spending on formal-long term care and other alternative explanations for our findings. In Section 6.4, we assess the cost-effectiveness of the LTCI program by comparing long-term care expenses to medical expenditures.

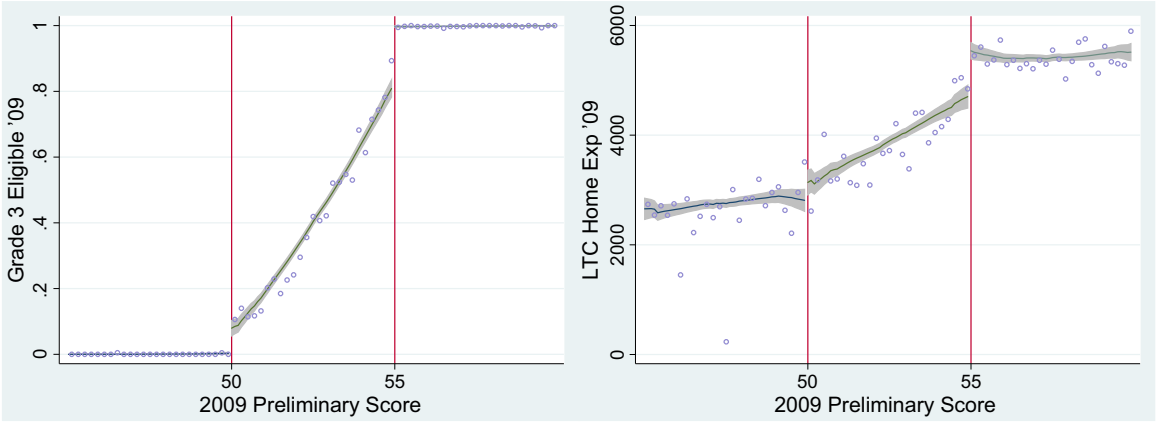
6.1. Grade 3 (home care only) benefits compared to no benefits

Fig. 2a displays the probability of eligibility for Grade 3 benefits (i.e. home care only) as a function of the preliminary score, and Column (1) of Table 3 the estimated increases in probability at 50 and 55. Scoring just above 50 leads to an 8 percentage point increase in the probability of eligibility for home care benefits while scoring just above 55 leads to a 17 percentage point increase.

[21] The provision of LTC services began in June 2008, and assessments began in April 2008. Though the program launch was known prior to June 2008, the legislation did not detail the scoring system. Moreover, details on the function that maps assessment characteristics to scores was not made publicly available. Therefore, any bunching around the thresholds at the onset are a result of the nonlinear properties of the scoring function, rather than manipulation of the score from learning by doing.

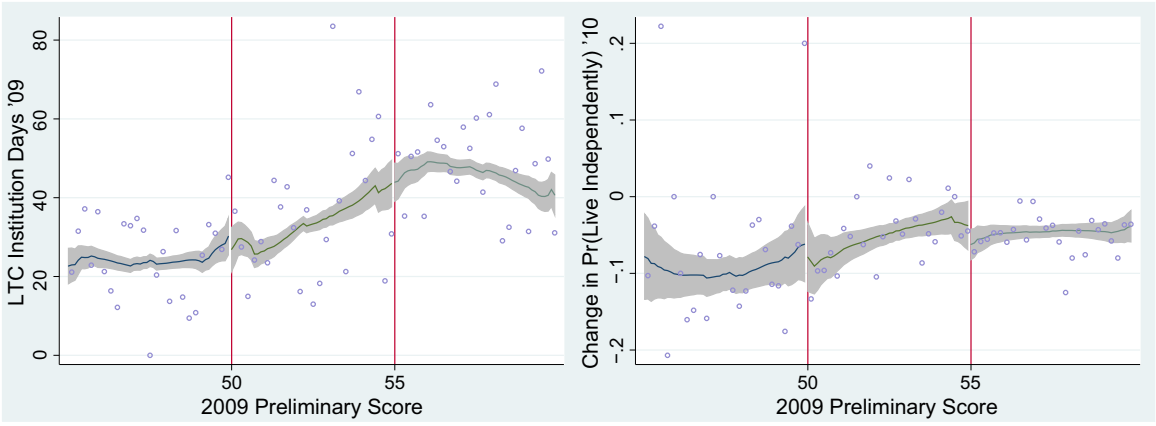
[22] We conducted this exercise for all questions and responses. This example is representative of our findings.

To address the impact of eligibility on utilization, Fig. 2b and c displays home care expenditures and facility care days, respectively, as a function of the preliminary score. Note that the pattern of utilization corresponds well with the pattern of eligibility. As the score increases from 45 to 60, home care expenditures increase with the probability of eligibility for home care benefits. In particular, there are discrete increases in expenditures at 50 and 55 corresponding to the discrete increases in the probability of eligibility for home care benefits at



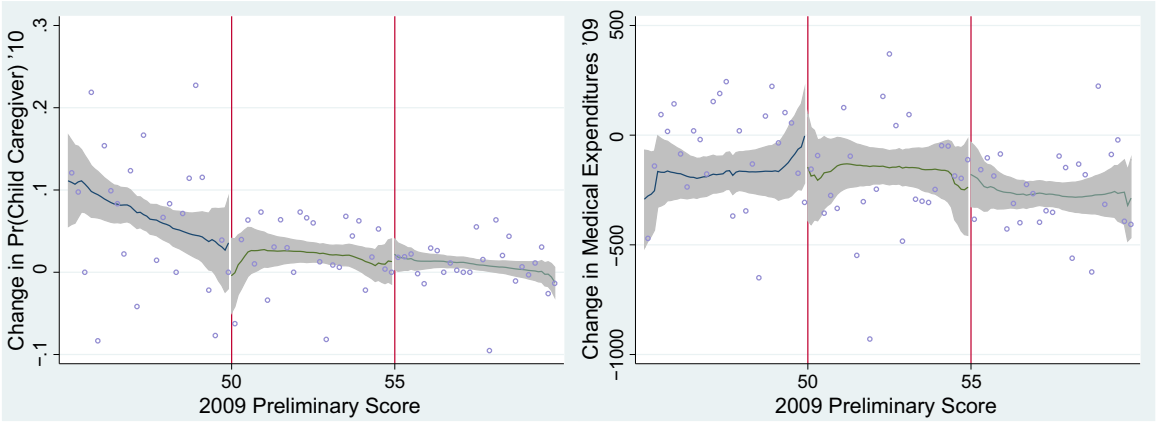
(a) Grade 3 Eligibility

(b) Home Care Expenditures



(c) Institutional Days

(d) Δ Independent Living



(e) Δ Child Caregiving

(f) Δ Medical Expenses

Notes: The running variable is the 2009 preliminary score, ranging from 45 to 60. The open circles plot the mean of the dependent variable within 0.2 point bins. The solid lines are fitted values from local linear regression of the dependent variable using a rectangular kernel with a bandwidth of 2.5 points. The shaded regions are 95 percent confidence intervals.

Fig. 2. Eligibility and outcomes around the Grade 3 thresholds.

those points. The fact that there is no statistically significant change in facility care utilization at the thresholds suggests that home health care is not a substitute for facility care for healthier people, which is consistent with most of the prior literature. Columns (4) to (6) of Table 3 contains estimates of the changes in total LTC expenditures, home care expenditures, and facility days at 50 and 55.

We now assess the corresponding impacts of these changes in formal care utilization on informal care. Fig. 2d and e displays the one year changes in the probabilities of living independently (living alone or with one's spouse) and having a child caregiver, respectively, as functions of the preliminary score. The probability of living independently over time falls across all scores as individuals get sicker on average. Moreover, the decrease is larger for those who were not eligible for Grade 3 benefits relative to those who were. In particular, the pattern corresponds to the pattern of home care utilization. Despite the overall patterns, however, the increased utilization of home care at the thresholds does not translate to a statistically significant change in the probability of living independently as estimated in Column (8) of Table 3. We find similar results for child caregiving. The change in child caregiving is positive across all scores as individuals age and become sicker over time. However, it increases trivially among those eligible for Grade 3 benefits, suggesting that formal home care is able to avert the use of informal care. Moreover, the use of child caregiving increases among those who were not eligible for Grade 3 benefits. Again, however, despite the overall patterns, the increased utilization at the thresholds is not associated with a statistically significant change in child caregiving as estimated in Column (7) of Table 3.

There are several possible explanations for the limited estimated impact on informal care. The first is that our estimates are not precise enough to rule out small, but potentially meaningful, changes. One other potential explanation is that individuals who are ineligible for home care benefits may be able to finance these services privately, so that the probability of living independently (having a child caregiver) would fall (increase) less than in the absence of such an option. Another potential explanation is that formal home care allows for a partial reduction, as opposed to complete elimination, of informal care. In other words, while there is no estimated impact on the extensive margin, there may still be an impact on the intensive margin. We address these potential explanations next in Section 6.1.1.

Lastly, we assess the impact of increased home care utilization on (non-LTC) medical expenditures and hospital utilization. Fig. 2f displays the one year changes in medical expenditures as a function of the preliminary score and Columns (9) and (10) of Table 3 present estimates for both outcomes. We find no evidence that home care use impacts these outcomes at the thresholds, or even across scores in the case of medical expenditures. We discuss these findings further in Section 6.4.

In summary, we find that eligibility for home care benefits leads to the utilization of formal home care. We also find that home and facility care are not substitutes for relatively healthy individuals. The use of formal home care has no statistically significant impact on the use of informal care at the extensive margin nor on medical utilization. There are various possible explanations for explaining the lack of an impact on informal care, which we now address.

6.1.1. Grade 3 benefits, crowd out, and informal care intensity

The analysis of Grade 3 benefits in the previous section indicates that an increase in home care expenditures has no statistically significant impact on informal care as measured by independent living and child caregiving. One possible explanation for this finding is that public financing simply crowds out private expenditures for home care. Another possible explanation is that publicly financed home care enables individuals to reduce informal caregiving at the intensive margin but not the extensive margin. Unfortunately, our data does not provide measures of private spending on home care, nor does it contain measures of the amount of caregiving. Instead we focus on a subpopulation of individuals—those in the MCA program and thus are poor—for whom the likelihood of out-of-pocket spending is expected to be very low.

Column (1) of Table 4 contains estimates of the increase in home care utilization at the Grade 3 thresholds for the subset of MCA individuals. As in the overall sample, Grade 3 benefits lead to an increase in home care expenditures for MCA individuals. Columns two and three contain estimates of the change in informal care. As in the overall population, there is no statistically significant impact of Grade 3 benefits on informal care at the extensive margin for MCA individuals. Given that MCA individuals are unlikely to pay for home care out of pocket, these results suggest that the lack of an observable impact on informal care

Table 3
Main results on eligibility, LTC utilization, informal care, and medical expenditures.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Eligibility	Formal LTC utilization					Informal care		Medical utilization	
Dependent variable	Eligibility	Pr (home care)	Pr (facility care)	LTC total expenditures	LTC home expenditures	LTC facility days	Δ Pr (child caregiver)	Δ Pr (live independently)	Δ Medical expenses	Δ Hospital expenses
Grade 3 benefit										
Score ≥ 50	0.08**	0.05*	−0.03+	208	311*	−2.3	−0.03	−0.02	−97	−177
	(0.01)	(0.02)	(0.02)	(169)	(157)	(3.6)	(0.04)	(0.04)	(174)	(174)
Mean at [47.5,50)	0.00	0.60	0.12	5120	4041	31.0	0.44	0.36	3430	1522
Score ≥ 55	0.17**	0.06**	0.001	931**	850**	0.3	0.01	−0.02	59	60
	(0.01)	(0.02)	(0.01)	(140)	(134)	(4.0)	(0.02)	(0.02)	(146)	(141)
Mean at [52.5,55)	0.58	0.73	0.13	6512	4950	44.8	0.45	0.33	3442	1498
Grade 2 benefit										
Score ≥ 70	0.04**	−0.06**	0.07**	524**	−392**	24.0**	−0.03*	−0.001	101	145
	(0.01)	(0.02)	(0.02)	(156)	(145)	(5.2)	(0.01)	(0.02)	(173)	(176)
Mean at [67.5,70)	0.00	0.71	0.26	8364	5109	89.5	0.46	0.09	4061	2305
Grade 1 benefit										
Score ≥ 95	0.83**	0.08**	−0.10**	1	926**	−29.4**	0.02	0.004	−691*	−666+
	(0.01)	(0.03)	(0.03)	(281)	(242)	(8.8)	(0.02)	(0.03)	(319)	(342)
Mean at [92.5,95)	0.05	0.48	0.58	10,870	3453	184.5	0.40	0.02	4748	3370

Notes: This table reports estimates of β from local linear regression of Eq. (1) with bandwidth 2.5 and rectangular kernel. For models 1 through 6, the dependent variable is the level of the outcome variable. For models 7 through 10, the dependent variable is the first difference of the outcome variable. For reference, the mean of the level of the outcome variable to the left of the threshold is reported. The running variable is the 2009 preliminary score. Controls include age, age squared, gender, region type dummies, insurance type dummies, health insurance contribution, and ADL index. Robust standard errors in parentheses.

** $p < 0.01$.

* $p < 0.05$.

+ $p < 0.1$.

Table 4
Utilization and informal care for MCA individuals.

	(1)	(2)	(3)
Dependent variable	LTC Home expenditures	Δ Pr (child caregiver)	Δ Pr (live independently)
Grade 3 benefit			
Score ≥ 50	476^{+}	0.06	−0.06
	(247)	(0.06)	(0.06)
Mean at [47.5,50)	3473	0.34	0.44
Score ≥ 55	930**	0.03	−0.04
	(232)	(0.02)	(0.03)
Mean at [52.5,55)	4712	0.34	0.44

Notes: This table reports estimates of β from local linear regression of Eq. (1) with bandwidth 2.5 and rectangular kernel. For model 1, the dependent variable is the level of the outcome variable. For models 2 and 3, the dependent variable is the first difference of the outcome variable. For reference, the mean of the level of the outcome variable to the left of the threshold is reported. The running variable is the 2009 preliminary score. Controls include age, age squared, gender, region type dummies, insurance type dummies, health insurance contribution, and ADL index. The sample consists of individuals in the MCA program. Robust standard errors in parentheses.
** $p < 0.01$.
$^{+}$ $p < 0.1$.

is not likely to be solely due to crowd out of private spending on formal care by public reimbursement.

A remaining explanation for why public reimbursement could have no impact on informal care at the extensive margin is that the impact is on the intensive margin. To shed light on this possibility, we look at the impact of Grade 3 benefits on the use of a particular home care service, short-term respite care. Short-term respite care is short-term (i.e. a few days) facility care used to provide temporary relief for the regular caregiver. Thus, use of this type of home care is a strong indication of a reduction in informal caregiving at the intensive margin. Indeed, as shown in Table 5, which shows estimates for several home care services, we find that Grade 3 benefits lead to a statistically significant increase in the use of short-term respite care at the 55 threshold.

6.2. Grade 2 (home or institutional care) benefits

We now assess the impact of Grade 2 benefits (i.e. where individuals can choose between home and institutional care benefits) on our outcomes of interest. Fig. 3a displays the probability of eligibility for Grade 2 benefits as a function of the preliminary score, and Column (1) of Table 3 the estimated increase in probability at 70. Scoring just above 70 leads to a 4 percentage point increase in the probability of eligibility for home and institutional care benefits.

To address the impact of eligibility on utilization, Fig. 3b and c display home care expenditures and facility care days as a function of the preliminary score. We see that home care expenditures decrease as individuals substitute facility care for home care. Moreover, there is a discrete increase in facility care use corresponding to the discrete increase in the probability of eligibility for institutional care at 70. Columns (4) to (6) of Table 3 contain estimates of the changes in total LTC expenditures, home care expenditures, and facility days at 70. The increase in eligibility at 70 leads to a 24 day increase in facility use and a $392 decrease in home care expenditures. Column (2) shows a reduction in home care use at the intensive margin, with a 6 percentage point reduction in the probability of having any home care expenditures.

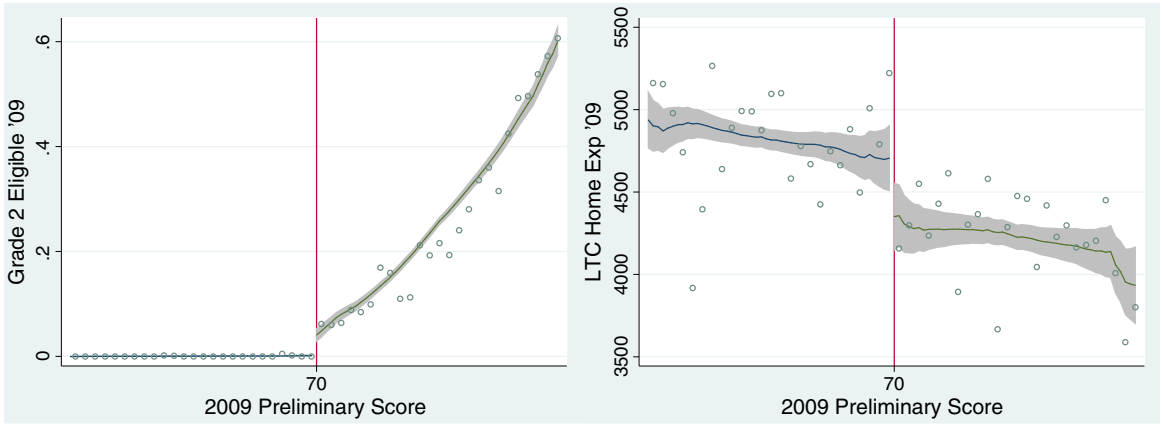
We next assess corresponding changes in informal care. Fig. 3d and e displays the one year change in the probabilities of living independently and having a child caregiver, respectively, as functions of the preliminary score. Again, we see that the change in the probability of living independently is negative across all scores as individuals get sicker over time, with the reduction slightly stronger for individuals eligible for facility benefits. However, there is no statistically significant change in independent living corresponding to the change in long term care utilization at 70, as estimated in Column (8) of Table 3. For child caregiving, we see that it falls with the onset of facility care benefits, mimicking the pattern of eligibility for Grade 2 benefits. There is also suggestive evidence that the increased utilization of facility care benefits over home care benefits at 70 translates to a reduction in child caregiving, consistent with estimates in Column (7) of Table 3. Estimates at the bandwidth of 2.5 suggest that Grade 2 benefits lead to a statistically significant decrease in the probability of child caregiving of 3 percentage points. Estimates at more stringent bandwidths suggest similarly negative impacts, but these estimates are not precise enough to be statistically significant.

There are several possible explanations for these findings. That there is no statistically significant impact on independent living may not be a surprise. While facility care substitutes for home care, they both are linked to dependent living situations. Although we did not find statistically significant impacts of home care on the use of child

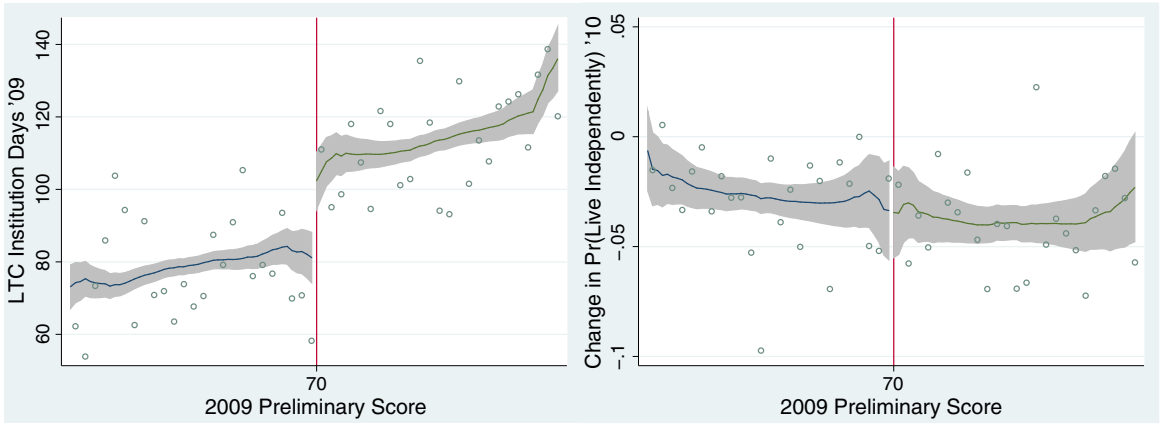
Table 5
Detailed home care utilization.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Home help	Home bath	Home nursing	Day/evening care	Respite care	Equipment
Grade 3 benefit						
Score ≥ 50	11.42*	0.04	0.06	−2.43	−0.74	2.85
	(4.76)	(0.45)	(0.20)	(1.81)	(1.31)	(2.07)
Mean at [47.5,50)	41.84	1.26	0.08	5.60	1.51	5.59
Score ≥ 55	16.02**	0.50	−0.33	2.39	6.67**	1.25
	(4.21)	(0.42)	(0.25)	(2.11)	(1.38)	(2.22)
Mean at [52.5,55)	75.38	2.75	0.31	9.39	1.01	11.34
Grade 2 benefit						
Score ≥ 70	−18.87**	−0.56	0.02	6.22**	1.27	0.01
	(4.29)	(0.44)	(0.21)	(1.97)	(2.14)	(2.04)
Mean at [67.5,70)	66.79	2.69	0.37	7.05	3.71	10.19
Grade 1 benefit						
Score ≥ 95	19.25**	1.29^{+}	−0.02	0.13	0.23	3.49
	(6.35)	(0.74)	(0.32)	(1.61)	(2.81)	(2.41)
Mean at [92.5,95)	40.61	2.68	0.22	2.17	2.03	5.55

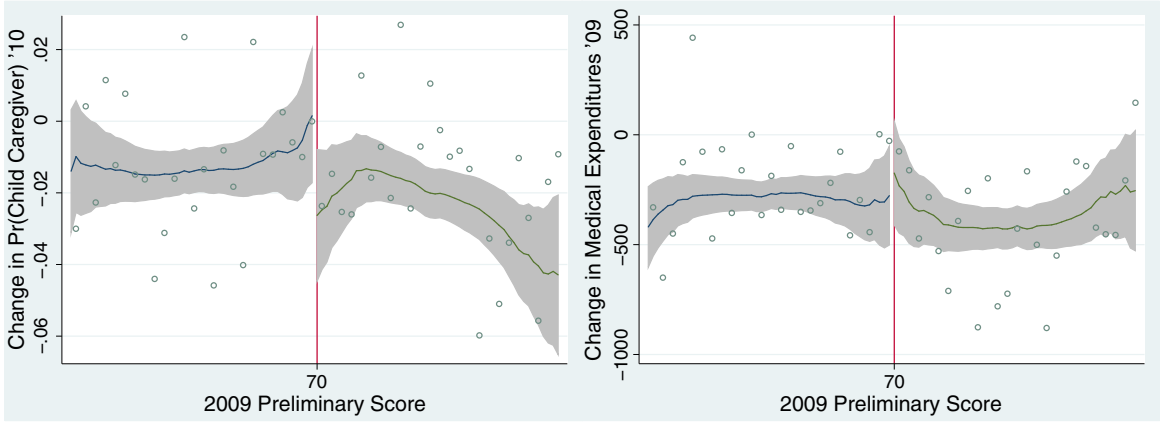
Notes: This table reports estimates of β from local linear regression of Eq. (1) with bandwidth 2.5 and rectangular kernel. For all models, the dependent variable is the level of the outcome variable. For reference, the mean of the dependent variable to the left of the threshold is reported. The running variable is the 2009 preliminary score. Controls include age, age squared, gender, region type dummies, insurance type dummies, health insurance contribution, and ADL index. Robust standard errors in parentheses.
** $p < 0.01$.
* $p < 0.05$.
$^{+}$ $p < 0.1$.



(a) Grade 2 Eligibility (b) Home Care Expenditures



(c) Institutional Days (d) Δ Independent Living



(e) Δ Child Caregiving (f) Δ Medical Expenses

Notes: The running variable is the 2009 preliminary score, ranging from 65 to 75. The open circles plot the mean of the dependent variable within 0.2 point bins. The solid lines are fitted values from local linear regression of the dependent variable using a rectangular kernel with a bandwidth of 2.5 points. The shaded regions are 95 percent confidence intervals.

Fig. 3. Eligibility and outcomes around the Grade 2 threshold.

caregiving, we do find suggestive impacts of facility care on the use of child caregiving. This is consistent with the fact that formal home care may reduce but not completely eliminate child caregiving. It is less likely that significant child caregiving would continue while the care recipient resides in a facility. We address these considerations more carefully in Section 6.2.1.

Lastly, we look at the impact of increased facility care and decreased home care utilization on medical expenditures and hospital

utilization. Fig. 3f displays the one year change in medical expenditures as a function of the preliminary score and Columns (9) and (10) of Table 3 present estimates for both outcomes. We find no evidence that the substitution of facility care for home care at 70 impacts these outcomes. We discuss these findings further in Section 6.4.

In summary, we find that eligibility for facility care benefits leads to the substitution of facility care for home care. This suggests that facility care could be a substitute for less able individuals. There is no statistically significant impact on independent living, but there is suggestive evidence of a reduction in child caregiving at the extensive margin. However, we find no statistically significant change in medical utilization. Moreover, it will be important to take into account the ability of individuals to pay for formal long-term care services out of pocket, which we address in Section 6.2.1.

6.2.1. Grade 2 benefits and crowd out

Analogously to Grade 3, Grade 2 benefits may lead to crowding out of facility care. To measure the extent of crowd out, we need a measure of all facility care, regardless of whether it is financed publicly or privately. Since we only observe publicly financed facility care in the data, we accomplish this by using an indirect measure of all facility utilization: medical spending occurring in a long-term care facility (i.e. regardless of financing). If the probability of having medical spending occurring in a long-term care facility is a fixed percentage of those who attend a long-term care facility (at the threshold), then changes in the probability of having medical spending occurring in a long-term care facility will capture changes in the probability of attending a long-term care facility. In other words, if $\frac{\#\text{ w/Medical Spending in LTC Facility}}{\#\text{ in LTC Facility}}$ is fixed, then a percentage increase in the denominator will be tied to a percentage increase in the numerator of the same magnitude.[23] Table 6 presents estimates of the impact at 70 of the probability of using a publicly financed long-term care facility and the probability of having medical spending occurring in a long-term care facility. Scoring just above 70 is associated with a 25% increase (6.5 percentage points on a base of 25.7%) in the probability of using publicly financed facility care. However, using the probability of medical spending occurring in a long-term care facility as a proxy for all facility care shows that the probability of using facility care, regardless of financing, increases only 18.4% (2.9 percentage points on a base of 15.6%) at 70. This suggests that 27.4% ($\approx\frac{25.4-18.4}{25.4}$) of publicly financed care is used to substitute for out of pocket expenditures. While this measure of crowd out is substantial, it also suggests that crowd out is not complete, and therefore cannot fully explain our lack of findings for informal care.

We also look at the impact of the Grade 2 benefit on the various types of home care utilization. Column (4) of Table 5 shows an increase in day and evening care, which is a short-term (day-by-day) facility stay, but which is captured as a home care service. This suggests that the changes in facility care and home care measured at the cutoff of 70 might be lower bounds. It is also consistent with the decrease in informal care at the intensive margin found in Column (7) of Table 3.

Table 6
Crowd out of facility care.

	(1)	(2)	(3)
	Pr (publicly financed facility care)	Pr (med spending in LTC facility)	Crowd out
Change at 70	0.065**	0.029*	
	(0.016)	(0.0135)	
Base at 70	0.257**	0.156**	
	(0.011)	(0.009)	
% Change at 70	25.4%**	18.4%+	27.4%
	(7.1%)	(9.7%)	(18.5%)

Notes: The first two columns report coefficient estimates from Eq. (1) with bandwidth 2.5 and rectangular kernel. Dependent variables are indicators for public reimbursement of facility care and medical spending in a LTC facility. The running variable is the 2009 preliminary score. Controls include age, age squared, gender, region type dummies, insurance type dummies, health insurance contribution, and ADL index. "Change at 'X'" is the estimate of β. "Base at 'X'" is the predicted value of the dependent variable at 'X' minus the "Change at 'X'".
** $p < 0.01$.
* $p < 0.05$.
+ $p < 0.1$.

6.3. Grade 1 (increased maximum for home care, increased price for institutional care) benefits

We now assess the impact of Grade 1 benefits on our outcomes of interest. Recall that these benefits are effectively an increase in the maximum benefit for home care combined with a discontinuous increase in the cost of facility care at the threshold. Fig. 4a displays the probability of eligibility for Grade 1 benefits as a function of the preliminary score, and Table 3 the estimated increase in probability at 95. A preliminary score just above 95 leads to an 83 percentage point increase in the probability of eligibility for Grade 1 benefits.

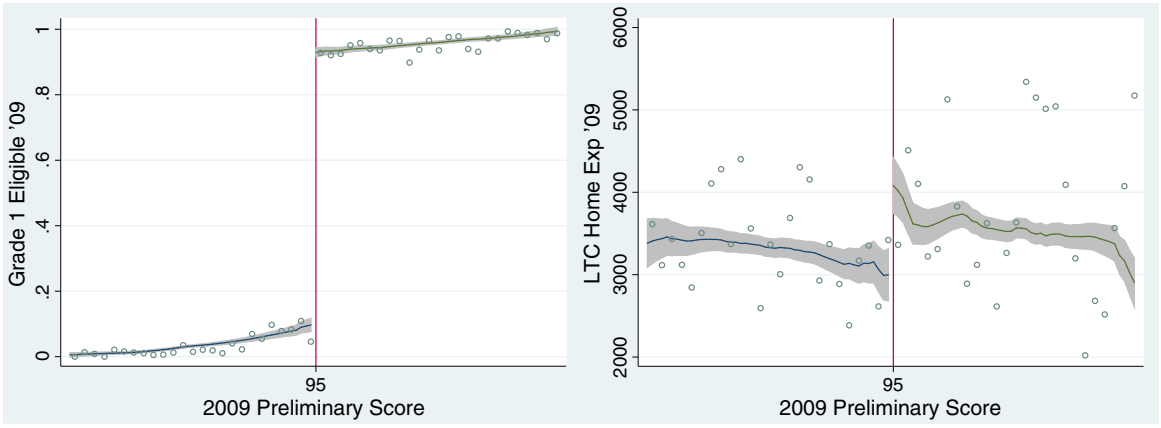
We address the impact of eligibility on utilization both at the extensive and intensive margin. Due to how Grade 1 benefits lead to a relative price increase in facility care, Columns (2) and (3) of Table 3 present estimates indicating that at the extensive margin, the probability of home care utilization increases by 8 percentage points while the probability of facility care use decreases by 10 percentage points. On average, Grade 1 benefits at 95 lead to a 30 day decrease in the number of facility days used and a $926 increase in home expenditures (see Columns [5] and [6] of Table 3, and Fig. 4b and c).[24]

The substitution of home care for facility care leads to a statistically significant and substantial decrease in medical utilization but not in informal care. As shown in Fig. 4d and e, with corresponding estimates in Columns (7) and (8) of Table 3, this shift in formal long-term care mix is not statistically significantly associated with changes in informal care, as measured by child caregiving and independent living. However, as shown in Fig. 4f and Columns (9) and (10) of Table 3, we do find a statistically significant decrease in medical expenses of almost $700, driven by a decrease in hospital expenditures of nearly the same amount. The fact that we find an impact of home care on medical expenditures in this case, but not for Grade 3 may be due to the fact that individuals who receive Grade 1 benefits are more frail and susceptible to health shocks that can be ameliorated by formal care. We discuss our findings on medical expenditures further in Section 6.4.

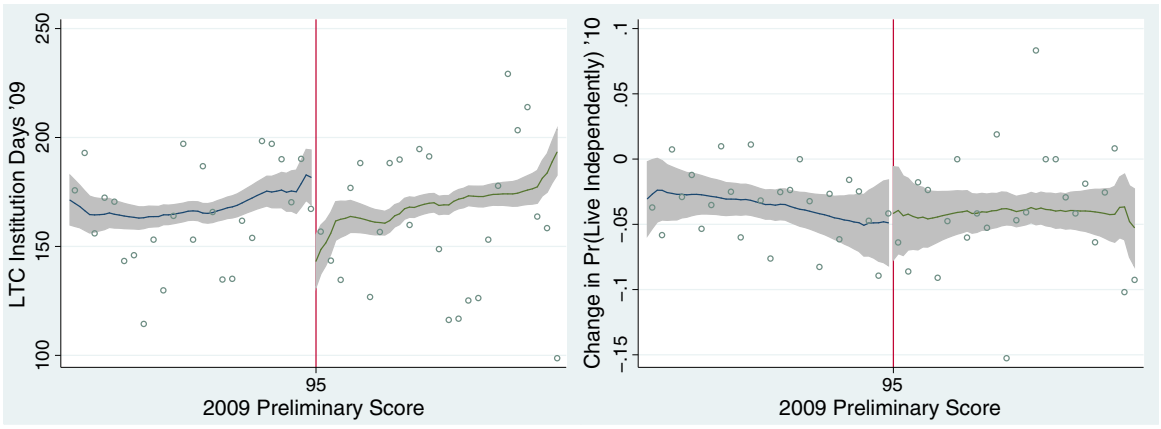
In summary, we find that a relative increase in the price of facility care leads to increased utilization of formal home care. This shift in formal long-term care services has no impact on informal care but has a substantial impact on medical expenses, largely due to decreased hospital expenditures.

[23] It is possible that those who spend out of pocket (i.e. those below the threshold) are likely to be sicker and thus have a higher probability of medical spending occurring in a facility. To the extent that this is the case, we will find a smaller change in the probability of having medical spending occurring in a facility and an over-estimate (upper bound) of crowdout.

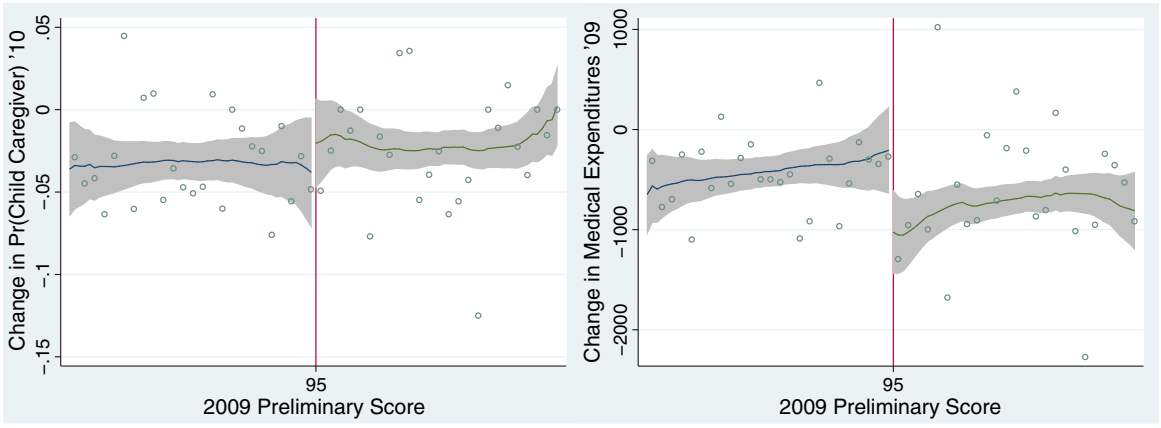
[24] Appendix Fig. B.3 presents the kernel densities of annual expenditures on home care for those who score [92.5, 95) compared to [95, 97.5). This provides additional insight into changes at the intensive and extensive margins of home care utilization. A smaller density at zero home care expenditures in those who score [95, 97.5) compared to [92.5,95) is consistent with a decrease in the probability of home care in Table 3. Moreover the increased number of individuals with home care expenditures greater than $10,800 (the maximum home care benefit for Grade 2) is consistent with the benefit change at the 95 threshold. For facility care, the impact is inherently on the extensive margin as institutional participants generally spend the full year in a facility, if at all.



(a) Grade 1 Eligibility (b) Home Care Expenditures



(c) Institutional Days (d) Δ Independent Living



(e) Δ Child Caregiving (f) Δ Medical Expenses

Notes: The running variable is the 2009 preliminary score, ranging from 90 to 100. The open circles plot the mean of the dependent variable within 0.2 point bins. The solid lines are fitted values from local linear regression of the dependent variable using a rectangular kernel with a bandwidth of 2.5 points. The shaded regions are 95 percent confidence intervals.

Fig. 4. Eligibility and outcomes around the Grade 1 threshold.

6.4. LTC expenditures and reductions in medical expenses

In light of the previous results showing decreases in medical expenditures, a useful metric for assessing the cost-effectiveness of this policy and its costs to the government is to compare the long-term care expenses to the changes in medical expenses. Recall that with the administrative data we use, we are able to measure the both the universe of medical expenditures and the universe of public long-

term care expenditures. Column (4) of Table 3 displays the estimated impacts on long-term care expenditures.

A preliminary score above 50 and 55 leads to a $208 and $931 increase in total long-term care expenditures, respectively. As seen earlier, however, this results in little, if any, statistically significant savings in medical expenditures. Focusing on Grade 2, we see that additional benefits for facility care lead to an additional $524 in expenditures as individuals substitute more expensive facility care in place of home care. However, corresponding to this increase in expenditure we find no statistically significant change in medical expenditures. Focusing on Grade 1, we see that additional benefits for Grade 1 lead to almost no change in long-term care expenditures as individuals tend to use more home care and less facility care. However, this substitution leads to large impacts on medical expenditures—nearly a $700 reduction. Clearly, the amount of long-term care is not a complete measure of the costs of the program as it does not include the administrative expenses, for example. Moreover, medical expenses are not a complete measure of the potential cost savings of the program as impacts on labor outcomes could have impacts on government revenue.[25] However, the large impact we measure here highlights the importance of considering the potential program savings from reduced medical expenditures.

7. Robustness

7.1. Differential mortality

Another relevant outcome is whether these benefits had any impact on mortality. This measure is important in and of itself, and is useful because it is objective and well-defined. Moreover, it is important to address the concern that differential mortality around the thresholds could account for our findings. For example, if individuals just below the threshold were more likely to die as a result of not receiving treatment, relatively healthy individuals would remain in the sample, minimizing any estimated impacts. We assess this by looking at mortality by 2010 around the thresholds. Appendix Table B.2 displays estimates of Eq. (1) with mortality by 2010 as the outcome. We find that the increase in long-term care utilization at the thresholds has no statistically significant impact on mortality in the short-run. However, our results are not precise, as our standard errors only allow us to identify effects on mortality of larger than two to four percentage points—such effects would be unexpectedly large given that the mortality rate is between two to four percent during the study period.

7.2. Other specifications

A consequential decision in estimating Eq. (1) is the choice of bandwidth. Although we have shown results at our preferred bandwidth of 2.5, it is useful to know how sensitive our findings are to bandwidth choice. To do so, we reestimate Eq. (1) for our main outcomes of interest at several bandwidths—from 1 to 5, in increments of 0.5. Appendix Figs. B.4 to B.7 plot the estimated coefficients with 95% confidence bands against the bandwidth. There are two things worth highlighting. First, coefficients are less precisely estimated and more variable at very small bandwidths. Second, the coefficient estimate at our preferred bandwidth falls within the 95% confidence bands of the estimates at other bandwidths in general, indicating that our findings are not too sensitive to bandwidth selection.

On the specification of $f(S)$, our approach in this paper follows Hahn, Todd, and van der Klaauw (2001) by using local linear regressions to estimate the discontinuity at the threshold. As shown in the previous section, our findings are consistent even at very small bandwidths. Moreover, visual inspection suggests the relationship between eligibility (as well as our outcomes of interest) and the preliminary score is fairly linear even at relatively large distances from the thresholds. Nonetheless, in Appendix Figs. B.8 to B.11 we explore how sensitive our findings are to higher order specifications of $f(S)$ at our preferred bandwidth. For the most part, the coefficient estimate based on a linear specification of $f(S)$ falls within the 95% confidence bands of estimates for higher order specifications. However, the variance of the higher order specifications grows quite large, which lends support for the use of linear splines.

On the specification of outcome variables as first differences, we pursued this approach in order to account for baseline differences in these variables. Appendix Table B.3 provides a comparison of the models where the dependent variable is the level of the outcome to models where the dependent variable is the first difference of the outcome. We find that the results are qualitatively the same with a few exceptions. Specifically, for medical and hospital expenditures at the 95 threshold, the direction and size of the coefficients between the first difference and level models are similar, though the results under the level model are not statistically significant. We feel that it is important to account for differences at baseline, so we place more confidence in the first difference results. However, we acknowledge the sensitivity of the results and that they should be interpreted with caution.[26]

7.3. Differences-in-differences estimation

Our research design takes advantage of a setting with a continuous measure of long-term care needs (i.e. the preliminary score) and thresholds that lead to "as good as random" variation in the probabilities of benefits. One limitation of this design, however, is the reduced precision from relying primarily on observations around the threshold. In this section, we estimate a differences-in-differences model that relies on stronger assumptions, but has potentially improved precision. Specifically, we compare three groups of individuals: individuals who are treated based solely on the preliminary score (for Grade 3, these are individuals with preliminary scores in [55,60)), individuals who are treated based on committee guidelines (for Grade 3, these are individuals with preliminary scores in [50,55)), and individuals who are not treated (for Grade 3, these are individuals with preliminary scores in [45,50)). For $\tau \in \{55, 75, 95\}$, we define $\text{commit}_\tau \equiv \mathbf{1}\{\tau - 5 \le S < \tau\}$ and $\text{treat}_\tau \equiv \mathbf{1}\{\tau \le S < \tau + 5\}$, where S is the 2009 preliminary score. When the untreated individuals (i.e. $\{S : \tau - 10 \le S < \tau - 5\}$) are the reference group, we estimate the following differences-in-differences model for an individual i at time t:

$$\text{outcome}_{it} = \sum_{t=0}^{1}\left(\beta_t^C \text{commit}_\tau \cdot t + \beta_t^T \text{treat}_\tau \cdot t\right) + \phi \cdot t + \varepsilon_{it}, \tag{2}$$

where t is 0 in the baseline year and 1 in the following year.[27] In all models, the dependent variable is the outcome specified in levels.[28] For Grade 2, we omit treat_{75} from the results because this group of individuals was not included in the main regression discontinuity analysis (out of concern for potential sorting around the 75 cutoff). Similarly, to be consistent with the main results for Grade 1 we focus on treat_{95}, with commit_{95} as the reference group.

The key assumption underlying this estimation method is that there are no unobserved factors that affect the three groups differentially over time. Ideally, assessing pretrends would allow us to assess this

[25] Our limited findings on informal care at the extensive margin suggest that these labor market impacts may be small.

[26] The results based on levels also suggest that formal long-term care leads to a reduction in informal caregiving. While these results are interesting and suggestive, we do not focus on these results because we place more confidence in the first difference results.

[27] Recall that the baseline year is 2008 for the medical expenditure related (NHI) variables and 2009 for all other (NLTCI) variables.

[28] While we accounted for baseline differences by specifying certain outcome variables in first differences when implementing the regression discontinuity design, we specify the outcome variables in levels when implementing the difference-in-differences design because it inherently accounts for baseline differences.

assumption. However, we are not able to do this due to data limitations, so the following results should be treated as suggestive.

Table 7 presents estimates of β_1^C and β_1^T from Eq. (2). Grade 3 expenditures lead to a statistically significant decrease in child caregiving, but have no statistically significant impact on independent living. There is no statistically significant impact on medical utilization. Additional long-term care expenditures resulting from Grade 2 benefits are not associated with statistically significant changes in child caregiving, independent living, and medical expenditures. The use of Grade 1 benefits leads to a decrease in medical expenditures, largely accounted for by hospital expenses. The findings from this analysis are fairly consistent with our findings from the regression discontinuity analysis. Even though the differences-in-differences analysis suggests statistically significant impacts on child caregiving while the main regression discontinuity estimates do not, this could be due to lack of statistical precision.

Lastly, for Grade 3 benefits, this estimation strategy allows us to compare the committee affected group to the automatically treated group. This is particularly relevant given that assigning treatment based solely on the preliminary score may not be optimal and that leaving room for discretionary assignment of treatment may improve efficiency. In this analysis, there do not appear to be any striking differences in performance between the two groups among Grade 3 individuals. Future analysis would be useful to ascertain whether a more discretionary decision-making procedure for determining treatment may be more (or less) effective than a hard rules-based criteria.

8. Discussion

In this paper, we estimate the first-year impact of subsidies for formal home and institutional care on informal care use and medical expenditures. Our main finding is that among the least able, transitioning from facility to home care results in substantially lower medical expenses. This may be mediated by the fact that the presence of medical professionals in a facility may lead to additional or more costly care than if one were being cared for at the home, and that, among this population of individuals, this effect predominates the previously mentioned effects. In fact, that transitioning people from institutions to the community may be beneficial is consistent with the objectives of programs such as Money Follows the Person in the U.S. This supports the more general point that our findings on medical expenses are not culturally or context specific, and that understanding the relationship between long-term care expenses and medical expenses may be a fruitful avenue to contain health care costs.

We also find that among the more able, publicly financed long-term care services lead to small, if any, impacts on informal care at the extensive margin. We determine that this is not solely due to crowdout, but is partly explained by the fact that informal care is reduced at the intensive margin. That we find limited impacts on informal care stands in contrast to some of the previous literature, but is not surprising given that family ties are relatively stronger in South Korea. That is, due to family obligations, Koreans may find it more difficult to give up completely the responsibility of taking care of their elderly parents. That we still find reductions in the intensive margin indicate that our results constitute a lower bound for the effect in the U.S., and may be directly indicative of countries with relatively stronger family ties, such as many developing countries, as well as immigrant populations from those countries.

9. Conclusion

Results from this paper provide insight into the welfare impacts of government reimbursement of long-term care on care recipients, caregivers, and taxpayers, as well as suggestions for the design of optimal long-term care policy. Our main finding is that the benefits of home and facility care are heterogeneous across physical function level and therefore that setting policy accordingly has the potential to dramatically reduce medical expenses. We also do not find statistically significant evidence that formal long-term care is a substitute for informal care at the extensive margin, but do find evidence at the intensive margin.

Among more able individuals, we find that government subsidies for formal home care lead to an overall increase in its utilization, even accounting for crowd out, with no statistically significant impact on informal caregiving at the extensive margin, medical expenses, or mortality. While we find evidence for a reduction in informal caregiving at the intensive margin, this suggests that if the policy objective is to increase the labor supply of individuals caring for this population, subsidies for home care may have little impact. Moreover, the converse of our findings on medical expenses and mortality suggest that home care reimbursement may be reduced without significant detriment to the health of the care recipient.

Table 7
Differences-in-differences estimates.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Eligibility	Formal LTC utilization					Informal care		Medical utilization	
Dependent variable	Eligibility	Pr (home Care)	Pr (facility care)	LTC total expenditures	LTC home expenditures	LTC facility days	Pr (child caregiver)	Pr (live independently)	Medical expenses	Hospital Expenses
Grade 3 benefit										
Score in [50,55)	0.414**	0.0658**	0.00113	1335**	990.6**	9.459**	−0.0846**	0.00961	31.05	25.84
"committee"	(0.00548)	(0.0112)	(0.00746)	(64.79)	(56.63)	(1.592)	(0.0153)	(0.0176)	(95.33)	(73.93)
Score in [55,60)	0.998**	0.104**	0.0123+	3039**	2235**	22.10**	−0.115**	0.0226	−95.61	−87.30
"treatment"	(0.000415)	(0.00946)	(0.00655)	(54.35)	(48.67)	(1.417)	(0.0134)	(0.0154)	(84.41)	(66.24)
Grade 2 benefit										
Score in [70,75)	0.239**	−0.0326**	0.0494**	489.9**	−538.7**	24.38**	0.00852	−0.0105	−142.6	−108.2
	(0.00379)	(0.00801)	(0.00746)	(60.43)	(51.66)	(1.989)	(0.00842)	(0.00911)	(94.00)	(83.51)
Grade 1 benefit										
Score in [95,100)	0.931**	−0.00265	−0.0198	333.8**	176.5*	−2.595	0.0130	0.00766	−273.4	−234.5
	(0.00334)	(0.0128)	(0.0128)	(111.0)	(89.06)	(3.422)	(0.0123)	(0.0132)	(171.4)	(161.1)

Notes: Post-period regression coefficients from differences-in-differences estimation of Eq. (2). The omitted category for each grade consists of those with preliminary scores in [45,50), [65,70), and [90,95), respectively. Robust standard errors in parentheses.

** $p < 0.01$.

* $p < 0.05$.

+ $p < 0.1$.

Among less able individuals, additional reimbursement of institutional care leads to an overall increase in its utilization, despite about 27% being used to substitute for out-of-pocket expenses, and corresponding statistically significant reductions in informal caregiving, but not medical expenses. This finding on informal caregiving suggests that this policy may lead to increased labor supply of individuals caring for this population. In this case, optimal policy depends on the objective function of the policymaker in balancing the tradeoff between increased taxpayer costs, reduced informal caregiving, and improved quality of life for the care recipient.

Among the least able, we find that an increase in the price of institutional care combined with an increase in the benefit maximum for home care leads to substitution of home care for institutional care. While we find no statistically significant impact on informal caregiving, we find substantial decreases in medical spending. From a policy perspective, this suggests that increased incentives for the use of home care may lead to an improvement in the welfare of care recipients while limiting or even reducing costs to taxpayers.

Appendix A and Appendix B. Supplementary Information

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jpubeco.2014.12.004.

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